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LEACHING OF ^{60}Co and ^{134}Cs FROM CEMENTED DECONTAMINATION WASTES

Report No 83-320-K

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ABSTRACT

Leaching of ^{60}Co and ^{134}Cs from treated decontamination wastes solidified with Portland Type 30 cement, Portland Type 30 cement/bentonite and Portland Type 30 cement/silicate matrices has been investigated to determine the matrix with the lowest leachability. After eighty days leaching, ^{134}Cs incremental leach rates averaged about 3.6×10^{-4} $cm \cdot d^{-1}$ for Portland Type 30 cement/bentonite products and 1.2×10^{-3} $cm \cdot d^{-1}$ for plain Portland Type 30 cement and Portland Type 30 cement/silicate waste forms while percentage cumulative releases averaged about 12.3% and 65.5% respectively. ^{60}Co releases from all cemented wastes were not significantly different from background levels. Within each matrix, ^{134}Cs releases increased as a result of waste type in the order of: Turco 4512 ≈ potassium persulfate ≫ Turco 4521A > alkaline permanganate ≈ peroxide bicarbonate. Predicted cumulative fractional releases from 210 L waste forms were estimated at 7.0% to 8.0% of those released from laboratory size products at any given leach time on a volume/surface area relationship.

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To Mr. F.J. Kee
Director of Research

LEACHING OF ^{60}Co AND ^{134}Cs FROM CEMENTED DECONTAMINATION WASTES

1.0 INTRODUCTION

Chemical decontamination of CANDU reactor systems and components produces large volumes of aqueous radioactive wastes which require treatment and conditioning prior to permanent disposal/1/. Acceptable formulations for the solidification of treated decontamination wastes with Portland Type 30 cement with and without additives were discussed in Research Report No 82-486-K and are summarized in Table I of this report. This table shows that the optimum formulations are sensitive to the chemical composition of the waste. For example, acceptable waste-to-matrix ratios (g/g) averaged 0.42 for peroxide bicarbonate, alkaline permanganate and Turco 4521A; 0.61 for Turco 4512 and 0.72 for potassium persulfate.

In this work, the leaching resistance of treated decontamination waste forms at the recommended compositions (Table I) has been investigated to determine the matrix with the lowest leachability. Because Ontario Hydro may dispose or store the solidified wastes in 210 L drums, predicted cumulative releases from full scale waste forms have also been calculated from the volume/surface area relationship between laboratory and full size specimens.

2.0 EXPERIMENTAL DETAILS

2.1 Preparation of Simulated Decontamination Wastes

Peroxide bicarbonate, alkaline permanganate, Turco 4521A, Turco 4512 and potassium persulfate solutions were prepared and treated as described in Research Report No 81-468-K.

TABLE I

COMPOSITION AND PHYSICAL PROPERTIES OF SIMULATED DECONTAMINATION WASTES SOLIDIFIED WITH PORTLAND TYPE 30 CEMENT WITH AND WITHOUT ADDITIVES

No	Decontamination Wastes	Volume of Waste (mL)	Original Activity nCi/mL Waste[1]		Density (g/mL)	Weight of Portland Type 30 Cement (g)	Weight of Additive (g)		Weight of Waste Form[2] (g)	Volume of Waste Form (cm^3)	Waste-to-Total Matrix Ratio (g/g)	Volume of Waste Form-to-Exposed Surface Area (cm)
			^{134}Cs	^{60}Co			Bentonite	Sodium Silicate				
1	Peroxide Bicarbonate	40	400	925	1.05	100	-	-	140.78	72.65	0.42	0.745
2	Peroxide Bicarbonate	44	341	750	1.05	100	10	-	151.49	76.58	0.42	0.761
3	Peroxide Bicarbonate	44	341	841	1.05	100	-	10	151.78	78.54	0.42	0.769
4	Alkaline Permanganate	40	375	925	1.09	100	-	-	137.34	72.65	0.436	0.745
5	Alkaline Permanganate	44	341	841	1.09	100	10	-	152.49	80.50	0.436	0.776
6	Alkaline Permanganate	44	341	750	1.09	100	-	10	151.85	82.47	0.436	0.783
7	Turco 4521A	40	400	925	1.03	100	-	-	135.11	68.72	0.412	0.729
8	Turco 4521A	44	341	841	1.03	100	10	-	149.61	78.54	0.412	0.769
9	Turco 4521A	44	341	841	1.03	100	-	10	148.07	78.54	0.412	0.769
10	Potassium Persulfate	70	214	471	1.10	100	-	-	168.30	98.18	0.77	0.833
11	Potassium Persulfate	70	200	471	1.10	100	10	-	182.90	104.10	0.70	0.849
12	Potassium Persulfate	70	200	471	1.10	100	-	10	180.20	106.03	0.70	0.854
13	Turco 4512	60	250	550	1.08	100	-	-	159.32	92.28	0.648	0.815
14	Turco 4512	60	250	550	1.08	100	10	-	167.90	96.21	0.589	0.827
15	Turco 4512	60	233	550	1.08	100	-	10	167.80	96.21	0.589	0.827

1. Activity levels used in this work are not significantly different from those found in actual decontamination wastes.
2. Weights were recorded after 42 days curing.

2.2 Preparation of Simulated Waste Forms

Simulated decontamination waste forms were prepared by labelling each treated waste with ^{134}Cs (average activity 304 nCi/mL) and ^{60}Co (average activity 752 nCi/mL) prior to cementation. The labelled radioactive wastes were then mixed with Portland Type 30 cement, Portland Type 30 cement/bentonite and Portland Type 30 cement/silicate mixtures using the compositions reported in Table I. The cement pastes were then poured into standard leaching cups (5.0 cm in diameter and 5.0 cm high) and cured for 32 days at 25±1°C and 50% relative humidity. At the end of the curing period, the waste forms were removed from the leaching cups, weighed and their dimensions recorded (Table I). The waste products were then leached according to the International Atomic Energy Agency's (IAEA) static leach test method, modified for whole body exposure to deionized water/2/. The water was replaced daily in the first four days, on the seventh day, weekly for the following three weeks, and then bimonthly thereafter.

2.3 Radioactivity Measurements

^{60}Co and ^{134}Cs releases were determined by γ-ray spectrometry using a Canberra multichannel analyzer fitted with a Ge(LI) detector (14% efficiency).

2.4 Data Analysis

As recommended by the IAEA leach test method/2/, incremental leach rates (R_n), cumulative fraction released (CFR) and percentage cumulative releases (PCR) were calculated using equations 1, 2 and 3/2,3/.

$$R_n = \left(\frac{A_n}{A_o}\right)\left(\frac{V}{S}\right)\left(\frac{1}{t_n}\right) \qquad (cm \cdot d^{-1}) \qquad (1)$$

$$CFR = \left(\frac{\Sigma A_n}{A_o}\right)\left(\frac{V}{S}\right), \text{ cm} \qquad (2)$$

$$\text{and} \quad PCR = \left(\frac{\Sigma A_n}{A_o}\right)(100) \qquad (3)$$

where

A_n = radioactivity released during each leaching period n (nCi)

ΣA_n = sum of radioactivity released during all leaching periods

A_o = initial radioactivity present in waste form (not corrected for radioactive decay).

V = volume of waste form (cm^3)

S = exposed surface area of waste form (cm^2)

t_n = duration of leachant renewal period (days, d).

3.0 LEACHING RESISTANCE

After eighty days of water immersion all waste forms had maintained their composite integrity as evidenced by the absence of swelling, shrinkage and/or surface damage.

3.1 ^{60}Co Releases

During the leach test period, ^{60}Co releases from all cemented wastes with and without additives were at background levels and thus were not used in the calculation of incremental and cumulative releases (Appendix 1). The low leachability of ^{60}Co can be explained on the basis of solubility and exchange reactions. ^{60}Co will react with hydroxide or carbonate ions in the cement matrix to form insoluble cobalt hydroxide and cobalt carbonate. In addition, ^{60}Co may exchange with calcium which is present in cement as tricalcium silicate, dicalcium silicate, tricalcium aluminate, and tetracalcium aluminoferrite to form the corresponding cobalt complexes which when crystallized become part of the hardened cement product/4,5/.

3.2 ^{134}Cs Releases

Incremental and cumulative releases of ^{134}Cs after 80 days leaching are tabulated in Appendix 1 and plotted as a function of total leaching time and as a function of the square root of total leaching time in Appendix 2. For all waste forms, the amount of ^{134}Cs leached in the early stages of the leach test comprises a significant fraction of the total amount leached. Reasons for this include an instantaneous wash-off of ^{134}Cs from the exposed surfaces, exchange reactions between ^{134}Cs and dissolved alkali elements present in the leachate as a result of water contact with the cemented wastes, solvation effects and high pH of the leachate (pH = 11.2) which facilitates the formation of soluble cesium hydroxide.

3.3 Effect of Cement Additives

Figure 1 compares the leaching performance of each decontamination waste solidified with plain Portland Type 30 cement, Portland Type 30 cement/bentonite and Portland Type 30 cement/silicate mixture. In all cases, the Portland Type 30 cement/bentonite matrix exhibited the lowest leachability. ^{134}Cs releases from this matrix were about one-third to one-fifteenth those released from plain Portland Type 30 cement and Portland Type 30 cement/silicate matrices. This is due to an irreversible trapping of ^{134}Cs within the bentonite crystal/6/. At the beginning of the leach test period, incremental leach rates for Portland Type 30 cement/bentonite waste products were between 4.0×10^{-3} to 3.2×10^{-2} $cm \cdot d^{-1}$ as compared with 2.0×10^{-2} and 1.0×10^{-1} $cm \cdot d^{-1}$ for plain Portland Type 30 cement and Portland Type 30 cement/silicate waste forms. After 80 days leaching, the incremental releases decreased to between 10^{-4} to 10^{-3} $cm \cdot d^{-1}$ and 10^{-4} to 10^{-2} $cm \cdot d^{-1}$, respectively. Cumulative fractional releases are summarized in Table II. This table shows that cumulative releases are sensitive to both the chemical composition of the waste and the type of cement additive used. Percentage cumulative releases from Portland Type 30 cement/bentonite samples ranged from 3% to 29% depending on waste composition as compared with 46% to 86% for plain Portland Type 30 cement and Portland Type 30 cement/silicate waste forms.

3.4 Effect of Waste Composition

Incremental and cumulative fractions released from all waste forms are displayed in Appendix 2 and Figure 2. Within each matrix, ^{134}Cs releases varied as follows: Turco 4512 ≈ potassium persulfate ≫ Turco 4521A ≥ alkaline permanganate ≈ peroxide bicarbonate. Differences in ^{134}Cs releases between the decontamination wastes may be explained on the basis of relative solubilities. Turco 4512 and potassium persulfate solutions contain soluble cesium phosphate and cesium persulfate which when cemented (high pH medium) form soluble cesium hydroxide which leaches readily. Turco 4521A, peroxide bicarbonate and alkaline permanganate wastes, however, form less soluble products such as cesium citrate, cesium carbonate, cesium permanganate and manganese oxide.

4.0 PREDICTION OF ^{134}Cs RELEASES FROM 210 L WASTE FORMS

Incremental and cumulative releases from cemented decontamination wastes are sensitive to the V/S ratio (Equations 1 and 2). Matsuzuru and Ito/7/ and Matsuzuru, Moriyama and Ito/8/ investigated the relationship between cumulative releases and the V/S ratio by measuring the amount of ^{134}Cs, ^{90}Sr and ^{60}Co leached from waste forms having V/S ratios of 0.40, 0.52, 0.75, 1.79 and

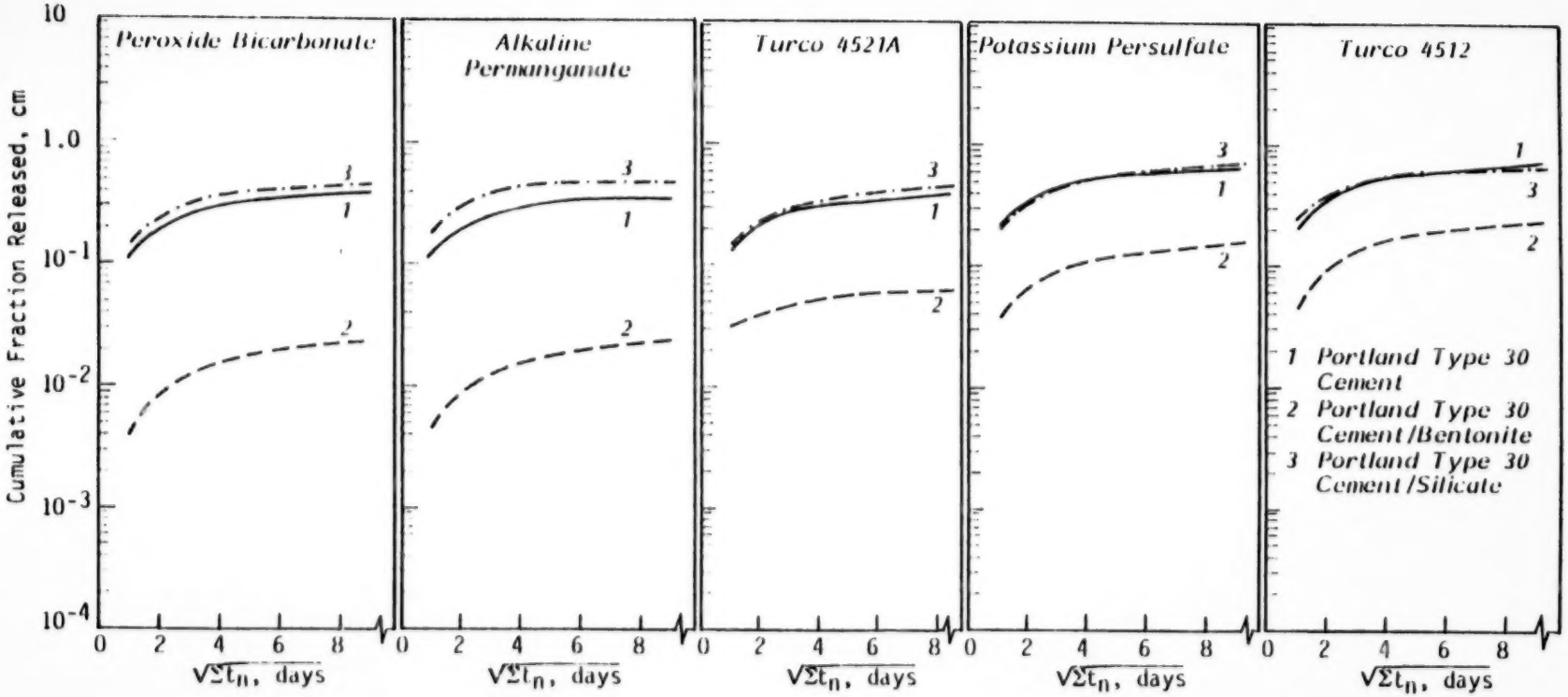

FIGURE 1

EFFECT OF MATRIX COMPOSITION ON ^{134}Cs CUMULATIVE RELEASES

TABLE II

COMPARISON OF CUMULATIVE RELEASES OF ^{134}Cs[1] FROM CEMENTED DECONTAMINATION WASTES AFTER EIGHTY DAYS LEACHING

No	Matrix / Decontamination Wastes	Portland Type 30 Cement		Portland Type 30 Cement/Bentonite Mixture		Portland Type 30 Cement/Silicate Mixture	
		$(\frac{\Sigma A_n}{A_o})(\frac{V}{S})$ (cm)	$(\frac{\Sigma A_n}{A_o})$ (100)	$(\frac{\Sigma A_n}{A_o})(\frac{V}{S})$ (cm)	$(\frac{\Sigma A_n}{A_o})$ (100)	$(\frac{\Sigma A_n}{A_o})(\frac{V}{S})$ (cm)	$(\frac{\Sigma A_n}{A_o})$ (100)
1	Peroxide Bicarbonate	0.383	51.37	0.0233	3.06	0.452	58.77
2	Alkaline Permanganate	0.343	46.04	0.0236	3.04	0.465	59.39
3	Turco 4521A	0.395	54.12	0.0644	8.37	0.443	57.53
4	Potassium Persultate	0.676	81.07	0.152	17.92	0.689	80.68
5	Turco 4512	0.705	86.47	0.240	28.95	0.660	78.75

1. ^{134}Cs releases were not corrected for radioactive decay.

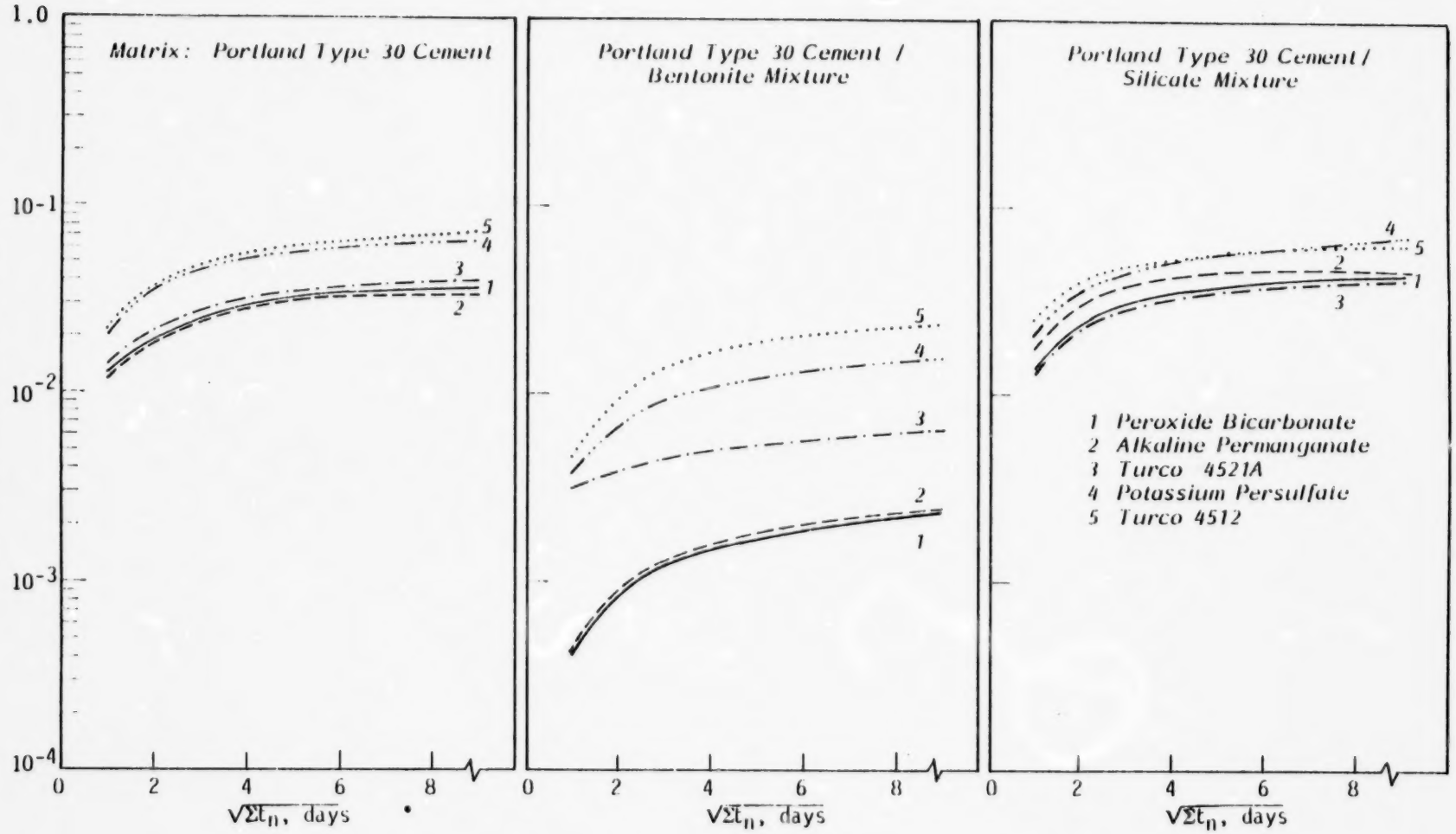

FIGURE 2

EFFECT OF WASTE COMPOSITION ON ^{134}Cs CUMULATIVE RELEASES

TABLE III

PREDICTED CUMULATIVE RELEASES OF ^{134}Cs FROM 210 L WASTE FORMS[1] AFTER EIGHTY DAYS LEACHING

No	Matrix / Decontamination Wastes	Portland Type 30 Cement			Portland Type 30 Cement/Bentonite Mixture			Portland Type 30 Cement/Silicate Mixture		
		$(\frac{\Sigma A_n}{A_o})_\ell$ [1]	$(\frac{\Sigma A_n}{A_o})_d$	$\frac{(\Sigma A_n/A_o)_d}{(\Sigma A_n/A_o)_\ell}$ (%)	$(\frac{\Sigma A_n}{A_o})_\ell$	$(\frac{\Sigma A_n}{A_o})_d$	$\frac{(\Sigma A_n/A_o)_d}{(\Sigma A_n/A_o)_\ell}$ (%)	$(\frac{\Sigma A_n}{A_o})_\ell$	$(\frac{\Sigma A_n}{A_o})_d$	$\frac{(\Sigma A_n/A_o)_d}{(\Sigma A_n/A_o)_\ell}$ (%)
1	Peroxide Bicarbonate	0.514	0.0364	7.1	0.0300	0.0022	7.2	0.588	0.0429	7.3
2	Alkaline Permanganate	0.461	0.0326	7.1	0.0304	0.0022	7.2	0.594	0.044	7.4
3	Turco 4521A	0.541	0.0375	6.9	0.0837	0.0061	7.3	0.443	0.0421	7.3
4	Potassium Persulfate	0.811	0.0642	7.9	0.1792	0.0144	8.0	0.807	0.0654	8.1
5	Turco 4512	0.865	0.067	7.7	0.290	0.0228	7.9	0.798	0.0627	7.9

1. $(V/S)_d$ - 10.53 cm whereas $(V/S)_\ell$ ranged between 0.7 to 0.8 cm
2. Cumulative releases were not corrected for radioactive decay.

10.5 cm. The results suggest that under the same leaching conditions, the fraction leached from a waste product (d) is proportional to its S/V ratio as shown in Equation 4/7,8,9/.

$$\left(\frac{\Sigma A_n}{A_o}\right)_d = \left(\frac{\Sigma A_n}{A_o}\right)_\ell \left(\frac{V}{S}\right)_\ell \left(\frac{S}{V}\right)_d \qquad (4)$$

Where A_n, A_o, S and V have their usual meaning and d refers to drum size waste form and ℓ refers to laboratory specimen.

Assuming Ontario Hydro will store or dispose of the cemented wastes in standard 210 L drums, the predicted cumulative releases from this size of waste form $\left(\frac{\Sigma A_n}{A_o}\right)_d$ can then be estimated from laboratory leaching data (Appendix 1) and Equation 4. The predicted cumulative releases after 80 days leaching are summarized in Table III. The data reveal that for all waste forms, $\left(\frac{\Sigma A_n}{A_o}\right)_d$ values are about 7% to 8% of the releases from laboratory specimens.

5.0 CONCLUSIONS

1. ^{60}Co releases from all cemented wastes were negligible.

2. ^{134}Cs releases from Portland Type 30 cement/bentonite matrix were one-third to one-fifteenth those released from plain Portland Type 30 cement and Portland Type 30 cement/silicate matrices.

3. For all matrices, ^{134}Cs releases from peroxide bicarbonate and alkaline permanganate waste forms were lower than the releases from Turco 4521A, potassium persulfate and Turco 4512 waste products.

4. The predicted cumulative releases $\left(\frac{\Sigma A_n}{A_o}\right)_d$ from 210 L waste forms are about 7% to 8% of those released from laboratory products having a V/S ratio of about 0.80 cm at any given leach time.

6.0. RECOMMENDATIONS

If decontamination wastes are to be solidified with cement, a mixture of Portland Type 30 cement with bentonite added at 10 g bentonite/kg cement) should be used because of the superior leaching performance of this combination.

To evaluate waste treatment effectiveness, storage and disposal systems, future research effort should focus on estimating radioactivity releases from the cemented wastes into the environment at any given time, t, particularly if t is much longer than the test period. This will involve fitting the experimental cumulative releases to various models and choosing the model with the best fit. Based on the recommended model, mechanism(s) describing radionuclide releases from the waste forms can then be proposed.

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APPENDIX 1

^{60}Co AND ^{134}Cs RELEASES FROM CEMENTED DECONTAMINATION WASTES

TABLE 1

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE	: PEROXIDE BICARBONATE (PB)		
COMPOSITION OF WASTE FORM	: 40 ml PB AND 100 g PORTLAND TYPE 30 CEMENT		
WASTE FORM MASS	: 140.78 g	ORIGINAL ACTIVITY	
WASTE FORM VOLUME (V)	: 72.65 cm^3	^{134}Cs	16000 nCi
EXPOSED SURFACE AREA(S)	: 97.39 cm^2	^{60}Co	37000 nCi
V/S RATIO	: 0.746 cm		
LEACHANT	: DEIONIZED WATER		
LEACHANT VOLUME	: 350.00 ml		

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs	^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	2500.0	< 200.0	2500.0	1.17E-01	1.17E-01	15.63
2	1.41	770.0	< 100.0	3270.0	3.59E-02	1.52E-01	20.44
3	1.73	570.0	< 50.0	3840.0	2.66E-02	1.79E-01	24.00
4	2.00	460.0	< 50.0	4300.0	2.14E-02	2.00E-01	26.87
7	2.65	880.0	< 100.0	5180.0	1.37E-02	2.42E-01	32.37
14	3.74	900.0	< 100.0	6080.0	5.99E-03	2.83E-01	38.00
21	4.58	540.0	< 100.0	6620.0	3.60E-03	3.09E-01	41.37
28	5.29	380.0	< 80.0	7000.0	2.53E-03	3.26E-01	43.75
80	8.94	1220.0	< 200.0	8220.0	1.09E-03	3.83E-01	51.37

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 ± .05 g/ml

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TABLE 2

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : PEROXIDE BICARBONATE (PB)
COMPOSITION OF WASTE FORM : 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

WASTE FORM MASS : 151.49 g

ORIGINAL ACTIVITY

WASTE FORM VOLUME (V): 76.58 cm^3
EXPOSED SURFACE AREA(S): 100.53 cm^2
V/S RATIO : 0.762 cm

^{134}Cs 15000 nCi
^{60}Co 33000 nCi

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	80.0	<	50.0	80.0	4.06E-03	4.06E-03	0.53
2	1.41	38.0	<	5.0	118.0	1.93E-03	5.99E-03	0.79
3	1.73	32.0	<	5.0	150.0	1.63E-03	7.62E-03	1.00
4	2.00	27.0	<	5.0	177.0	1.37E-03	8.99E-03	1.18
7	2.65	55.0	<	5.0	232.0	9.31E-04	1.18E-02	1.55
14	3.74	55.0	<	5.0	287.0	3.99E-04	1.46E-02	1.91
21	4.58	38.0	<	5.0	325.0	2.76E-04	1.65E-02	2.17
28	5.29	32.0	<	5.0	357.0	2.32E-04	1.81E-02	2.38
80	8.94	102.0	<	10.0	459.0	9.96E-05	2.33E-02	3.06

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

TABLE 3

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE	: PEROXIDE BICARBONATE (PB)		
COMPOSITION OF WASTE FORM	: 44 ml PB, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE		
WASTE FORM MASS	: 151.78 g	ORIGINAL ACTIVITY	
WASTE FORM VOLUME (V)	: 78.54 cm^3	^{134}Cs	15000 nCi
EXPOSED SURFACE AREA(S)	: 102.10 cm^2	^{60}Co	37000 nCi
V/S RATIO	: 0.769 cm		
LEACHANT	: DEIONIZED WATER		
LEACHANT VOLUME	: 350.00 ml		

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	2700.0	<	200.0	2700.0	1.38E-01	1.38E-01	18.00
2	1.41	920.0	<	100.0	3620.0	4.72E-02	1.86E-01	24.13
3	1.73	630.0	<	50.0	4250.0	3.23E-02	2.18E-01	28.33
4	2.00	490.0	<	50.0	4740.0	2.51E-02	2.43E-01	31.60
7	2.65	910.0	<	100.0	5650.0	1.56E-02	2.90E-01	37.67
14	3.74	890.0	<	100.0	6540.0	6.52E-03	3.35E-01	43.60
21	4.58	560.0	<	100.0	7100.0	4.10E-03	3.64E-01	47.33
28	5.29	426.0	<	100.0	7526.0	3.12E-03	3.86E-01	50.17
80	8.94	1290.0	<	200.0	8816.0	1.27E-03	4.52E-01	58.77

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 ! .05 g/ml

TABLE 4

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE	: ALKALINE PERMANGANATE (AP)		
COMPOSITION OF WASTE FORM	: 40 ml AP AND 100 g PORTLAND TYPE 30 CEMENT		
WASTE FORM MASS	: 137.34 g	ORIGINAL ACTIVITY	
WASTE FORM VOLUME (V):	72.65 cm^3	^{134}Cs	16000 nCi
EXPOSED SURFACE AREA(S):	97.39 cm^2	^{60}Co	37000 nCi
V/S RATIO	: 0.746 cm		
LEACHANT	: DEIONIZED WATER		
LEACHANT VOLUME	: 350.00 ml		

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	2600.0	<	200.0	2600.0	1.21E-01	1.21E-01	16.25
2	1.41	690.0	<	50.0	3290.0	3.22E-02	1.53E-01	20.56
3	1.73	545.0	<	50.0	3835.0	2.54E-02	1.79E-01	23.97
4	2.00	460.0	<	50.0	4295.0	2.14E-02	2.00E-01	26.84
7	2.65	892.0	<	100.0	5187.0	1.39E-02	2.42E-01	32.42
14	3.74	950.0	<	100.0	6137.0	6.33E-03	2.86E-01	38.36
21	4.58	610.0	<	100.0	6747.0	4.06E-03	3.15E-01	42.17
28	5.29	470.0	<	100.0	7217.0	3.13E-03	3.36E-01	45.11
80	8.94	150.0	<	100.0	7367.0	1.34E-04	3.43E-01	46.04

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 ± .05 g/ml

TABLE 5

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : ALKALINE PERMANGANATE (AP)
COMPOSITION OF WASTE FORM : 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

WASTE FORM MASS : 152.89 g

WASTE FORM VOLUME (V): 80.50 cm^3
EXPOSED SURFACE AREA(S): 103.67 cm^2
V/S RATIO : 0.777 cm

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

ORIGINAL ACTIVITY

^{134}Cs	15000 nCi
^{60}Co	37000 nCi

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	83.0	<	50.0	83.0	4.30E-03	4.30E-03	0.55
2	1.41	37.0	<	5.0	120.0	1.92E-03	6.21E-03	0.80
3	1.73	30.0	<	5.0	150.0	1.55E-03	7.77E-03	1.00
4	2.00	26.0	<	5.0	176.0	1.35E-03	9.11E-03	1.17
7	2.65	52.0	<	5.0	228.0	8.97E-04	1.18E-02	1.52
14	3.74	53.0	<	5.0	281.0	3.92E-04	1.45E-02	1.87
21	4.58	37.0	<	5.0	318.0	2.74E-04	1.65E-02	2.12
28	5.29	32.0	<	10.0	350.0	2.37E-04	1.81E-02	2.33
80	8.94	106.0	<	10.0	456.0	1.06E-04	2.36E-02	3.04

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 ± .05 g/ml

TABLE 6

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE	: ALKALINE PERMANGANATE (AP)		
COMPOSITION OF WASTE FORM	: 44 ml AP, 100 g PORTLAND TYPE 30 CEMENT, AND 10 g SILICATE		
WASTE FORM MASS	: 151.85 g	ORIGINAL ACTIVITY	
WASTE FORM VOLUME (V)	: 82.47 cm^3	^{134}Cs	15000 nCi
EXPOSED SURFACE AREA(S)	: 105.24 cm^2	^{60}Co	33000 nCi
V/S RATIO	: 0.784 cm		
LEACHANT	: DEIONIZED WATER		
LEACHANT VOLUME	: 350.00 ml		

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	3400.0	<	200.0	3400.0	1.78E-01	1.78E-01	22.67
2	1.41	1150.0	<	100.0	4550.0	6.01E-02	2.38E-01	30.33
3	1.73	750.0	<	50.0	5300.0	3.92E-02	2.77E-01	35.33
4	2.00	546.0	<	50.0	5846.0	2.85E-02	3.05E-01	38.97
7	2.65	952.0	<	100.0	6798.0	1.66E-02	3.55E-01	45.32
14	3.74	950.0	<	100.0	7748.0	7.09E-03	4.05E-01	51.65
21	4.58	600.0	<	100.0	8348.0	4.48E-03	4.36E-01	55.65
28	5.29	430.0	<	100.0	8778.0	3.21E-03	4.59E-01	58.52
80	8.94	131.0	<	100.0	8909.0	1.32E-04	4.65E-01	59.39

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 ± .05 g/ml

TABLE 7

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : TURCO 4521A
COMPOSITION OF WASTE :
FORM : 40 ml TURCO 4521A AND 100 g PORTLAND TYPE 30 CEMENT

WASTE FORM MASS : 135.33 g

WASTE FORM VOLUME (V): 68.72 cm^3
EXPOSED SURFACE AREA(S): 94.25 cm^2
V/S RATIO : 0.729 cm

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

ORIGINAL ACTIVITY

^{134}Cs 16000 nCi
^{60}Co 37000 nCi

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	2900.0	<	200.0	2900.0	1.32E-01	1.32E-01	18.12
2	1.41	860.0	<	100.0	3760.0	3.92E-02	1.71E-01	23.50
3	1.73	610.0	<	50.0	4370.0	2.78E-02	1.99E-01	27.31
4	2.00	460.0	<	50.0	4830.0	2.10E-02	2.20E-01	30.19
7	2.65	820.0	<	100.0	5650.0	1.25E-02	2.57E-01	35.31
14	3.74	850.0	<	100.0	6500.0	5.53E-03	2.96E-01	40.63
21	4.58	530.0	<	100.0	7030.0	3.45E-03	3.20E-01	43.94
28	5.29	380.0	<	80.0	7410.0	2.47E-03	3.38E-01	46.31
80	8.94	1250.0	<	200.0	8660.0	1.10E-03	3.95E-01	54.12

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

TABLE 8

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE	: TURCO 4521A		
COMPOSITION OF WASTE FORM	: 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE		
WASTE FORM MASS	: 149.61 g	ORIGINAL ACTIVITY	
WASTE FORM VOLUME (V)	: 78.54 cm^3	^{134}Cs	15000 nCi
EXPOSED SURFACE AREA(S)	: 102.10 cm^2	^{60}Co	37000 nCi
V/S RATIO	: 0.769 cm		
LEACHANT	: DEIONIZED WATER		
LEACHANT VOLUME	: 350.00 ml		

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	620.0	<	100.0	620.0	3.18E-02	3.18E-02	4.13
2	1.41	60.0	<	5.0	680.0	3.08E-03	3.49E-02	4.53
3	1.73	48.0	<	5.0	728.0	2.46E-03	3.73E-02	4.85
4	2.00	43.0	<	5.0	771.0	2.21E-03	3.95E-02	5.14
7	2.65	86.0	<	5.0	857.0	1.47E-03	4.39E-02	5.71
14	3.74	90.0	<	5.0	947.0	6.59E-04	4.86E-02	6.31
21	4.58	68.0	<	5.0	1015.0	4.98E-04	5.21E-02	6.77
28	5.29	55.0	<	20.0	1070.0	4.03E-04	5.49E-02	7.13
60	8.94	185.0	<	100.0	1255.0	1.82E-04	6.44E-02	8.37

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 ± .05 g/ml

TABLE 9

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : TURCO 4521A
COMPOSITION OF WASTE :
FORM : 44 ml TURCO 4521A, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

WASTE FORM MASS : 148.07 g

WASTE FORM VOLUME (V): 78.54 cm^3
EXPOSED SURFACE AREA(S): 102.10 cm^2
V/S RATIO : 0.769 cm

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

ORIGINAL ACTIVITY

^{134}Cs	16000 nCi
^{60}Co	37000 nCi

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	2700.0	<	200.0	2700.0	1.30E-01	1.30E-01	16.87
2	1.41	930.0	<	100.0	3630.0	4.47E-02	1.75E-01	22.69
3	1.73	655.0	<	50.0	4285.0	3.15E-02	2.06E-01	26.78
4	2.00	450.0	<	50.0	4735.0	2.16E-02	2.28E-01	29.59
7	2.65	940.0	<	100.0	5675.0	1.51E-02	2.73E-01	35.47
14	3.74	950.0	<	100.0	6625.0	6.52E-03	3.19E-01	41.41
21	4.58	620.0	<	100.0	7245.0	4.26E-03	3.48E-01	45.28
28	5.29	470.0	<	100.0	7715.0	3.23E-03	3.71E-01	48.22
80	8.94	1490.0	<	200.0	9205.0	1.38E-03	4.43E-01	57.53

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

TABLE 10

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE	: POTASSIUM PERSULFATE (PP)		
COMPOSITION OF WASTE FORM	: 70 ml PP AND 100 g PORTLAND TYPE 30 CEMENT		
WASTE FORM MASS	: 168.30 g	ORIGINAL ACTIVITY	
WASTE FORM VOLUME (V)	: 98.18 cm^3	^{134}Cs	15000 nCi
EXPOSED SURFACE AREA(S)	: 117.81 cm^2	^{60}Co	33000 nCi
V/S RATIO	: 0.833 cm		
LEACHANT	: DEIONIZED WATER		
LEACHANT VOLUME	: 350.00 ml		

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs	^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	3700.0	< 200.0	3700.0	2.06E-01	2.06E-01	24.67
2	1.41	1300.0	< 100.0	5000.0	7.22E-02	2.78E-01	33.33
3	1.73	915.0	< 100.0	5915.0	5.08E-02	3.29E-01	39.43
4	2.00	720.0	< 100.0	6635.0	4.00E-02	3.69E-01	44.23
7	2.65	1250.0	< 50.0	7885.0	2.31E-02	4.38E-01	52.57
14	3.74	1290.0	< 100.0	9175.0	1.02E-02	5.10E-01	61.17
21	4.58	810.0	< 100.0	9985.0	6.43E-03	5.55E-01	66.57
28	5.29	576.0	< 120.0	10561.0	4.57E-03	5.87E-01	70.41
80	8.94	1600.0	< 200.0	12161.0	1.71E-03	6.76E-01	81.07

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

TABLE 11

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : POTASSIUM PERSULFATE (PP)
COMPOSITION OF WASTE :
FORM : 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

WASTE FORM MASS : 182.90 g

WASTE FORM VOLUME (V): 104.10 cm^3
EXPOSED SURFACE AREA(S): 122.52 cm^2
V/S RATIO : 0.850 cm

ORIGINAL ACTIVITY

^{134}Cs 14000 nCi
^{60}Co 33000 nCi

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	640.0	<	50.0	640.0	3.88E-02	3.88E-02	4.57
2	1.41	160.0	<	50.0	800.0	9.71E-03	4.86E-02	5.71
3	1.73	190.0	<	50.0	990.0	1.15E-02	6.01E-02	7.07
4	2.00	160.0	<	50.0	1150.0	9.71E-03	6.98E-02	8.21
7	2.65	290.0	<	50.0	1440.0	5.87E-03	8.74E-02	10.29
14	3.74	290.0	<	50.0	1730.0	2.51E-03	1.05E-01	12.36
21	4.58	200.0	<	50.0	1930.0	1.73E-03	1.17E-01	13.79
28	5.29	157.0	<	30.0	2087.0	1.36E-03	1.27E-01	14.91
80	8.94	422.0	<	100.0	2509.0	4.93E-04	1.52E-01	17.92

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

TABLE 12

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : POTASSIUM PERSULFATE (PP)
COMPOSITION OF WASTE :
FORM : 70 ml PP, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

WASTE FORM MASS : 180.20 g

WASTE FORM VOLUME (V): 106.03 cm^3
EXPOSED SURFACE AREA(S): 124.09 cm^2
V/S RATIO : 0.854 cm

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

ORIGINAL ACTIVITY

^{134}Cs	14000 nCi
^{60}Co	33000 nCi

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	3400.0	<	200.0	3400.0	2.08E-01	2.08E-01	24.29
2	1.41	1170.0	<	100.0	4570.0	7.14E-02	2.79E-01	32.64
3	1.73	810.0	<	100.0	5380.0	4.94E-02	3.28E-01	38.43
4	2.00	620.0	<	100.0	6000.0	3.78E-02	3.66E-01	42.86
7	2.65	1030.0	<	100.0	7030.0	2.10E-02	4.29E-01	50.21
14	3.74	1230.0	<	100.0	8260.0	1.07E-02	5.04E-01	59.00
21	4.58	760.0	<	100.0	9020.0	6.63E-03	5.51E-01	64.43
28	5.29	545.0	<	110.0	9565.0	4.75E-03	5.84E-01	68.32
80	8.94	1730.0	<	200.0	11295.0	2.03E-03	6.89E-01	80.68

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

TABLE 13

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : TURCO 4512
COMPOSITION OF WASTE :
FORM : 60 ml TURCO 4512 AND 100 g PORTLAND TYPE 30 CEMENT

WASTE FORM MASS : 159.32 g

WASTE FORM VOLUME (V): 92.28 cm^3
EXPOSED SURFACE AREA(S): 113.10 cm^2
V/S RATIO : 0.816 cm

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

ORIGINAL ACTIVITY

^{134}Cs 15000 nCi
^{60}Co 33000 nCi

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs	^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	4000.0	< 200.0	4000.0	2.18E-01	2.18E-01	26.67
2	1.41	1210.0	< 100.0	5210.0	6.58E-02	2.83E-01	34.73
3	1.73	940.0	< 100.0	6150.0	5.11E-02	3.35E-01	41.00
4	2.00	690.0	< 50.0	6840.0	3.75E-02	3.72E-01	45.60
7	2.65	1340.0	< 100.0	8180.0	2.43E-02	4.45E-01	54.53
14	3.74	1460.0	< 100.0	9640.0	1.13E-02	5.24E-01	64.27
21	4.58	920.0	< 100.0	10560.0	7.15E-03	5.74E-01	70.40
28	5.29	650.0	< 175.0	11210.0	5.05E-03	6.10E-01	74.73
80	8.94	1760.0	< 200.0	12970.0	1.84E-03	7.05E-01	86.47

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

TABLE 14

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : TURCO 4512
COMPOSITION OF WASTE :
FORM : 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g BENTONITE

WASTE FORM MASS : 167.90 g

WASTE FORM VOLUME (V): 96.21 cm^3
EXPOSED SURFACE AREA(S): 116.24 cm^2
V/S RATIO : 0.828 cm

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

ORIGINAL ACTIVITY

^{134}Cs	15000 nCi
^{60}Co	33000 nCi

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	820.0	<	100.0	820.0	4.52E-02	4.52E-02	5.47
2	1.41	380.0	<	50.0	1200.0	2.10E-02	6.62E-02	8.00
3	1.73	315.0	<	50.0	1515.0	1.74E-02	8.36E-02	10.10
4	2.00	270.0	<	50.0	1785.0	1.49E-02	9.85E-02	11.90
7	2.65	489.0	<	50.0	2274.0	8.99E-03	1.25E-01	15.16
14	3.74	510.0	<	50.0	2784.0	4.02E-03	1.54E-01	18.56
21	4.58	390.0	<	50.0	3174.0	3.07E-03	1.75E-01	21.16
28	5.29	300.0	<	70.0	3474.0	2.36E-03	1.92E-01	23.16
80	8.94	869.0	<	200.0	4343.0	9.22E-04	2.40E-01	28.95

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

TABLE 15

^{134}Cs AND ^{60}Co RELEASES FROM CEMENTED DECONTAMINATION WASTES

WASTE : TURCO 4512
COMPOSITION OF WASTE :
FORM : 60 ml TURCO 4512, 100 g PORTLAND TYPE 30 CEMENT AND 10 g SILICATE

WASTE FORM MASS : 167.80 g

WASTE FORM VOLUME (V): 96.21 cm^3
EXPOSED SURFACE AREA(S): 116.24 cm^2
V/S RATIO : 0.828 cm

LEACHANT : DEIONIZED WATER
LEACHANT VOLUME : 350.00 ml

ORIGINAL ACTIVITY

^{134}Cs 14000 nCi
^{60}Co 33000 nCi

TIME (DAYS)	SQRT TIME	-- INCREMENTAL --- RELEASES (nCi) - ^{134}Cs		^{60}Co	TOTAL RELEASE (nCi)	INCREMENTAL LEACH RATE (cm/DAY)	CUMULATIVE FRACTION (cm)	CUMULATIVE RELEASE %
1	1.00	4200.0	<	200.0	4200.0	2.48E-01	2.48E-01	30.00
2	1.41	1230.0	<	100.0	5430.0	7.27E-02	3.21E-01	38.79
3	1.73	770.0	<	50.0	6200.0	4.55E-02	3.67E-01	44.29
4	2.00	590.0	<	50.0	6790.0	3.49E-02	4.01E-01	48.50
7	2.65	970.0	<	100.0	7760.0	1.91E-02	4.59E-01	55.43
14	3.74	1010.0	<	100.0	8770.0	8.53E-03	5.18E-01	62.64
21	4.58	600.0	<	100.0	9370.0	5.07E-03	5.54E-01	66.93
28	5.29	445.0	<	125.0	9815.0	3.76E-03	5.80E-01	70.11
80	8.94	1350.0	<	200.0	11165.0	1.53E-03	6.60E-01	79.75

VALUES BELOW DETECTION LIMIT ARE SET TO ZERO
^{60}Co WAS NOT USED IN CALCULATIONS SINCE NO VALUES WERE ABOVE THE DETECTION LIMIT.

DENSITY OF WASTE IS 1.05 $\pm$ .05 g/ml

APPENDIX 2

PLOTS OF INCREMENTAL AND CUMULATIVE RELEASES OF ^{134}Cs AS A FUNCTION OF TOTAL LEACHING PERIOD

FIGURE 1

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE: PEROXIDE BICARBONATE (PB)

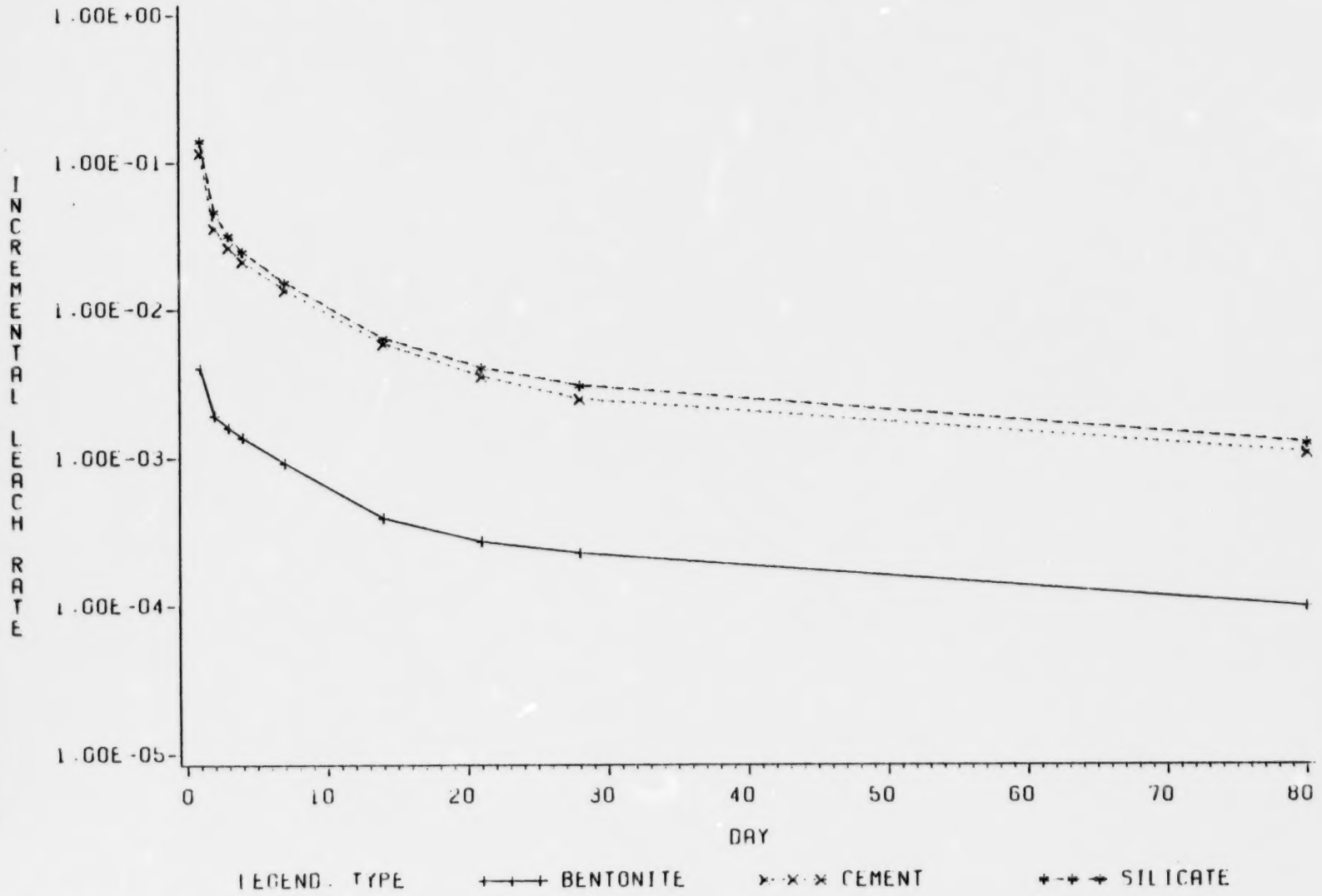


FIGURE 2

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE: ALKALINE PERMANGANATE (AP)

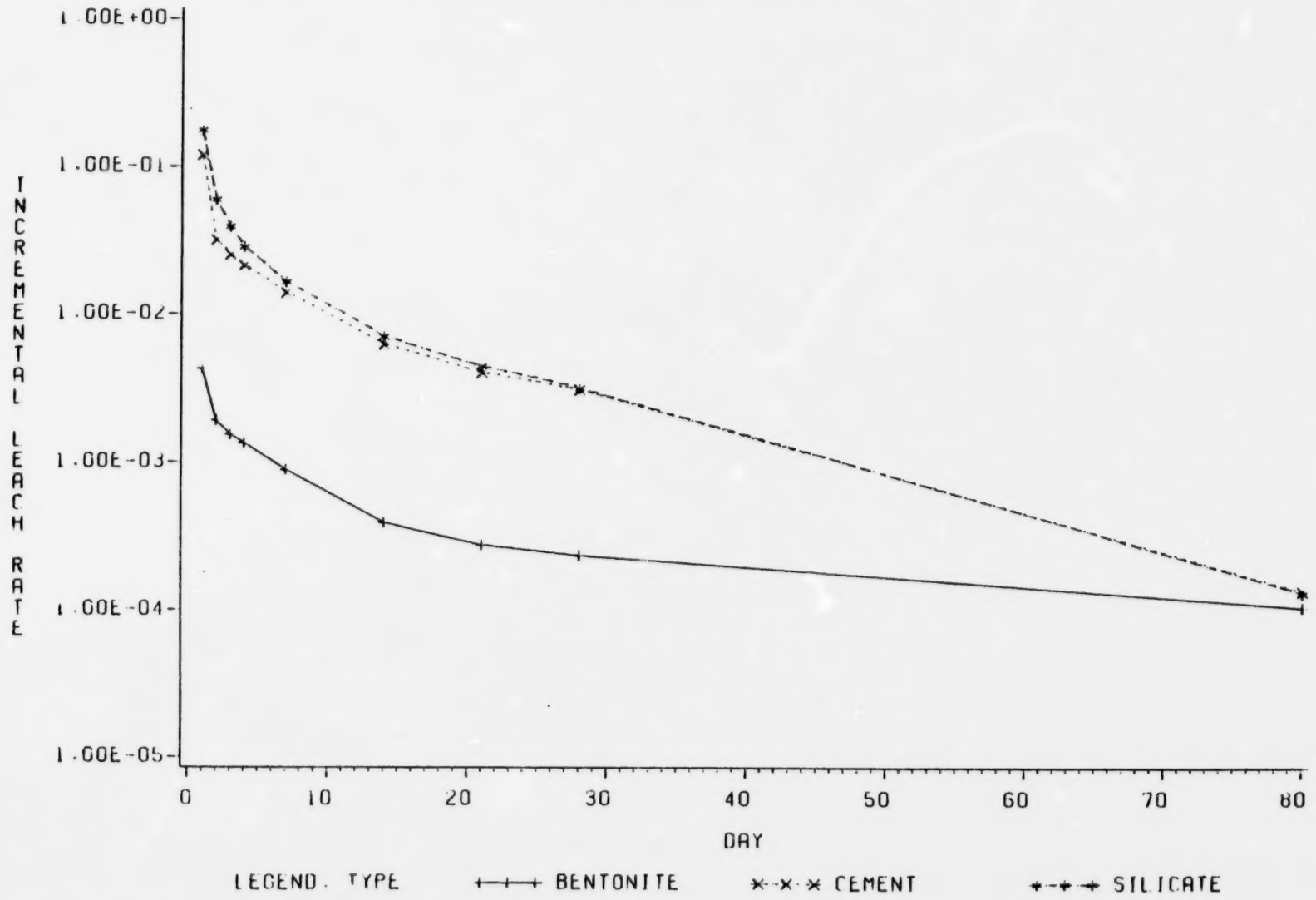


FIGURE 3

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE=TURCO 4521A

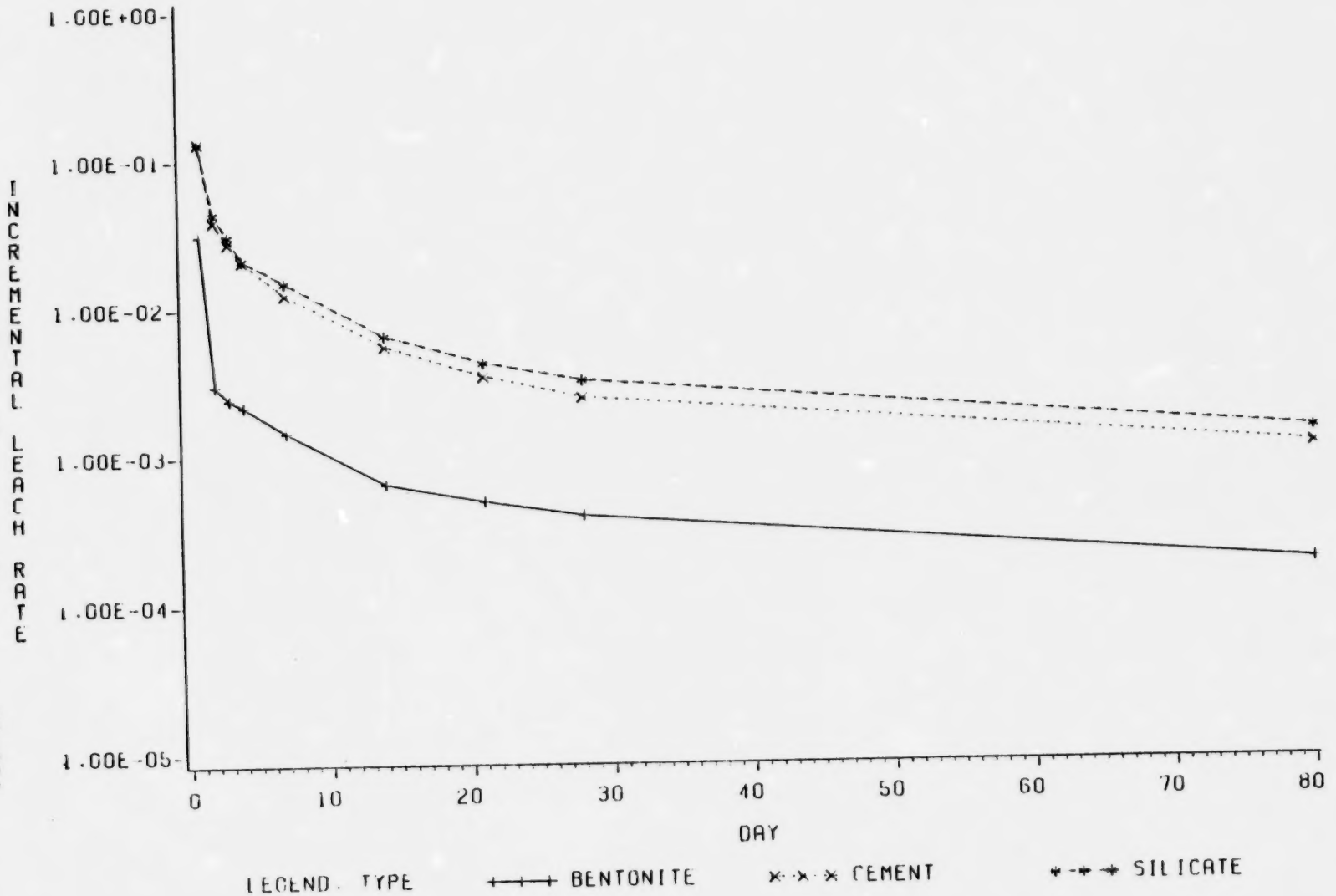


FIGURE 4

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE=POTASSIUM PERSULFATE (PP)

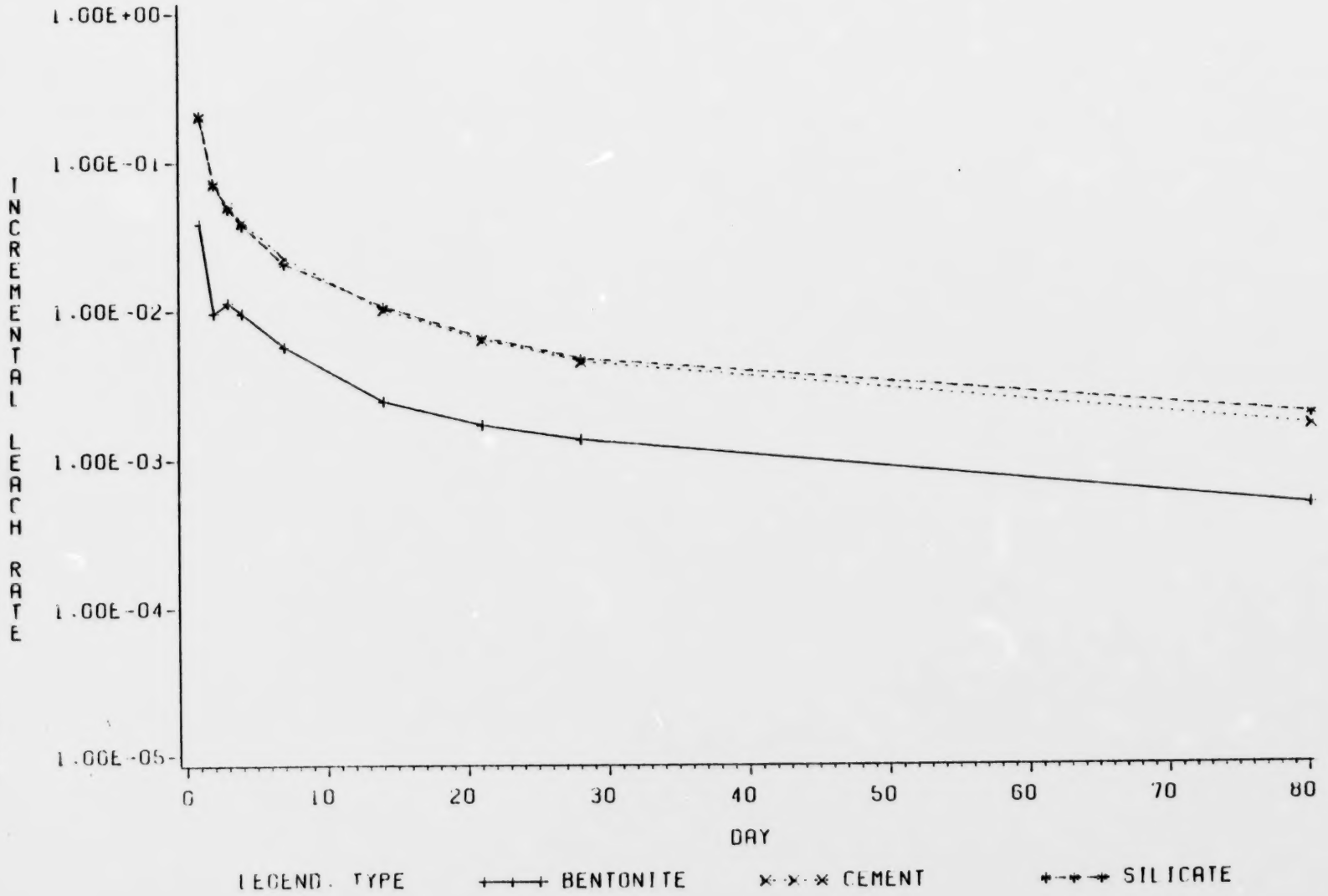


FIGURE 5

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE=TURCO 4512

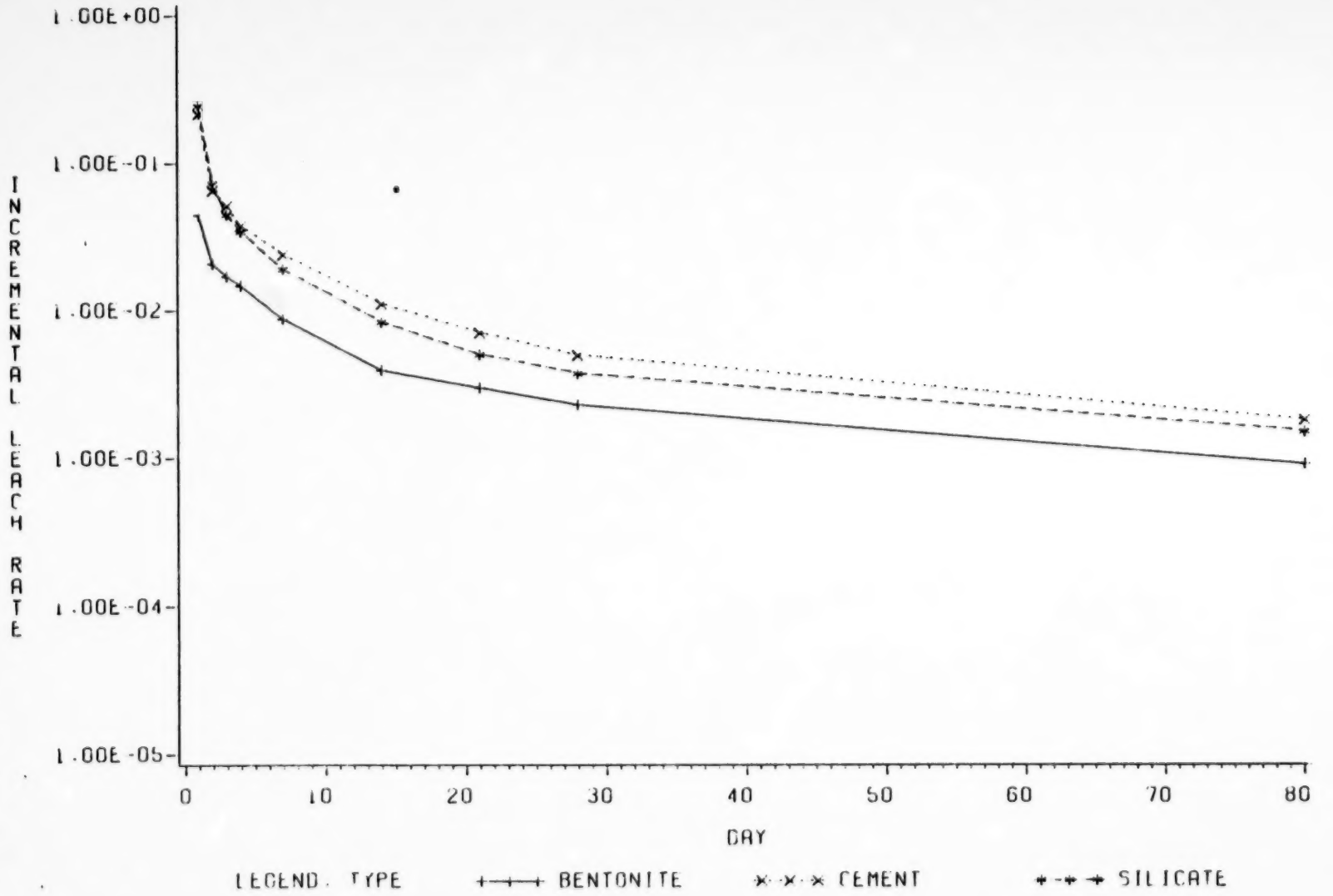


FIGURE 6

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE: PEROXIDE BICARBONATE (PB)

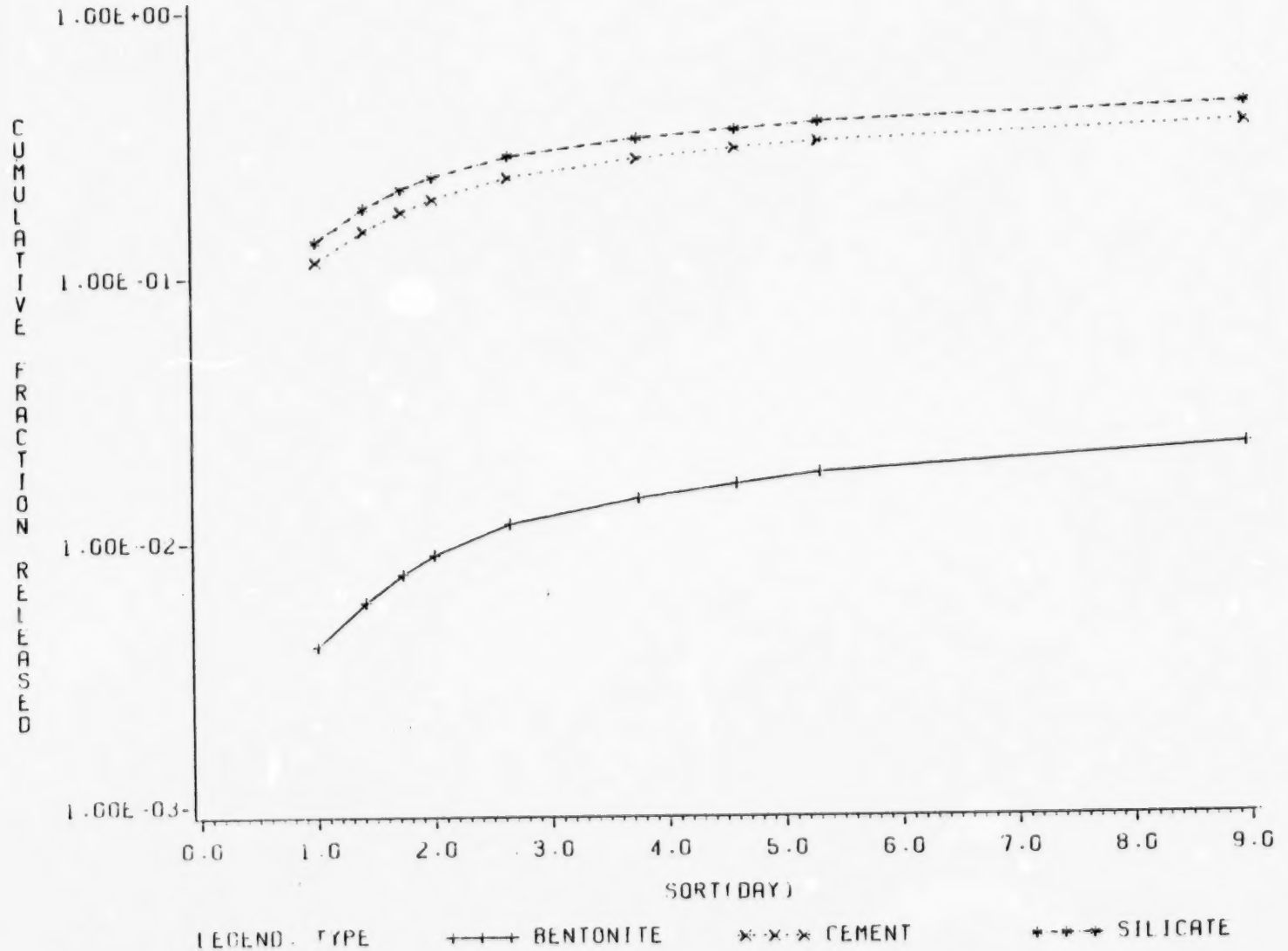


FIGURE 7

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE=ALKALINE PERMANGANATE (AP)

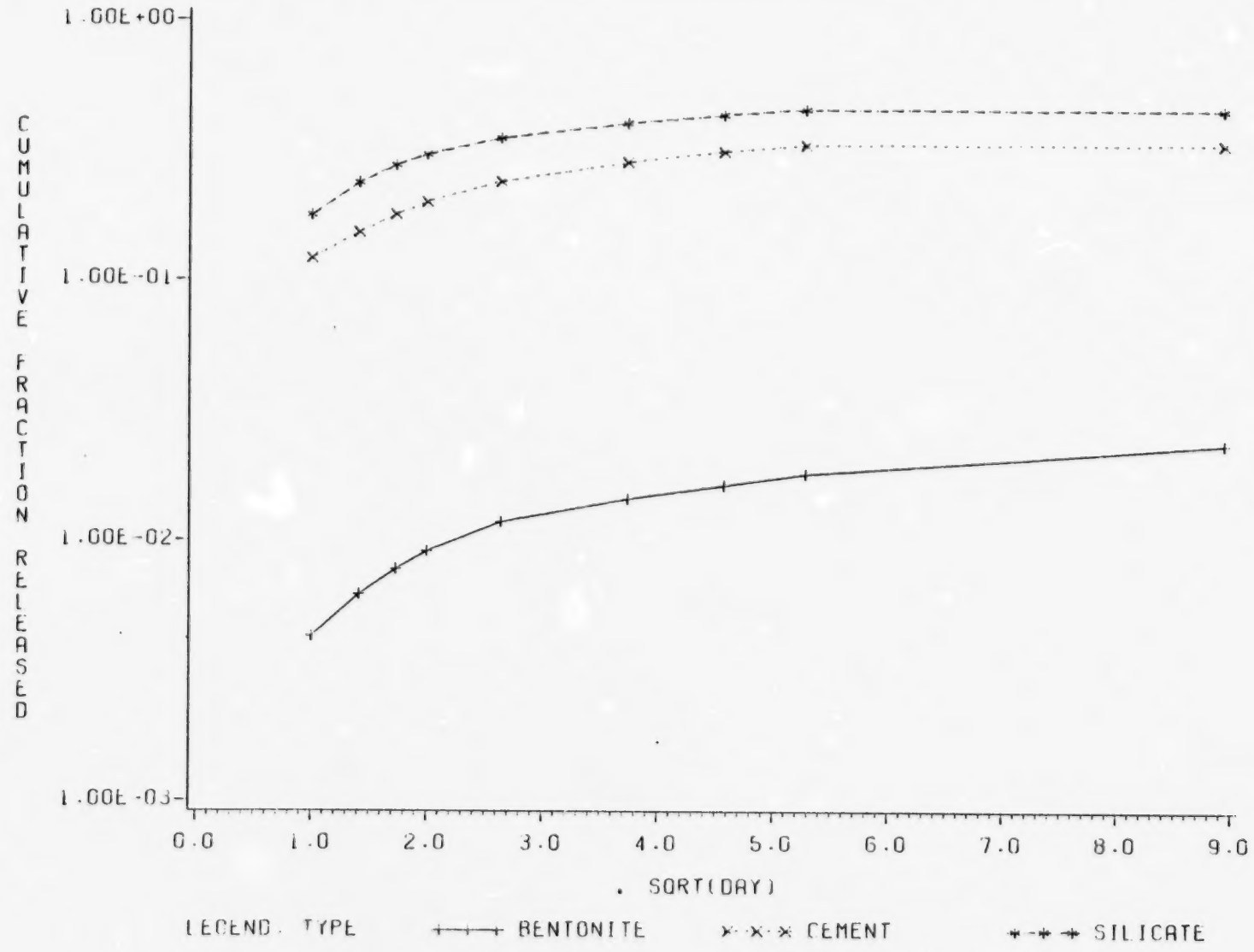
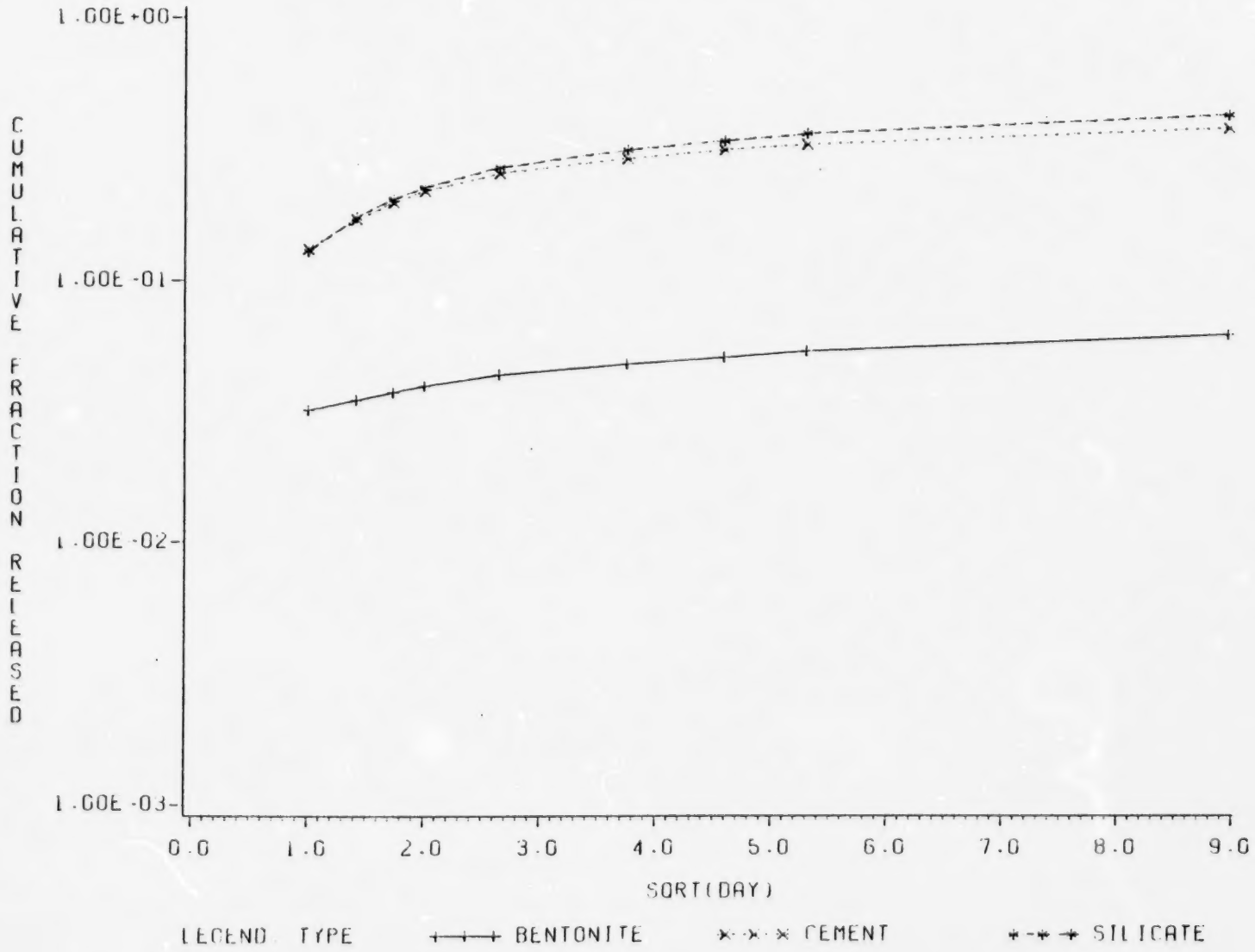


FIGURE 8

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE: TURCO 4521A



LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE=POTASSIUM PERSULFATE (PP)

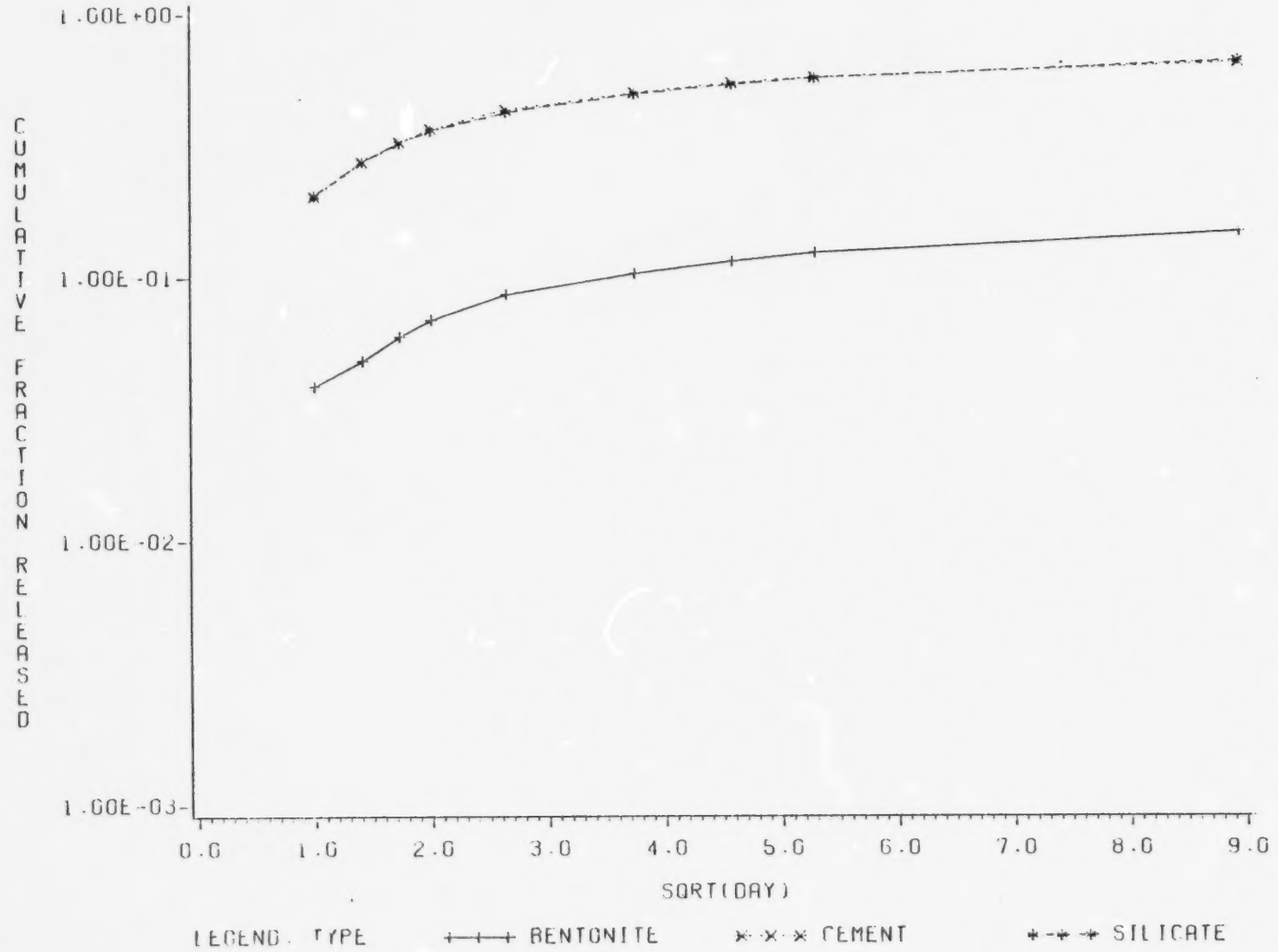
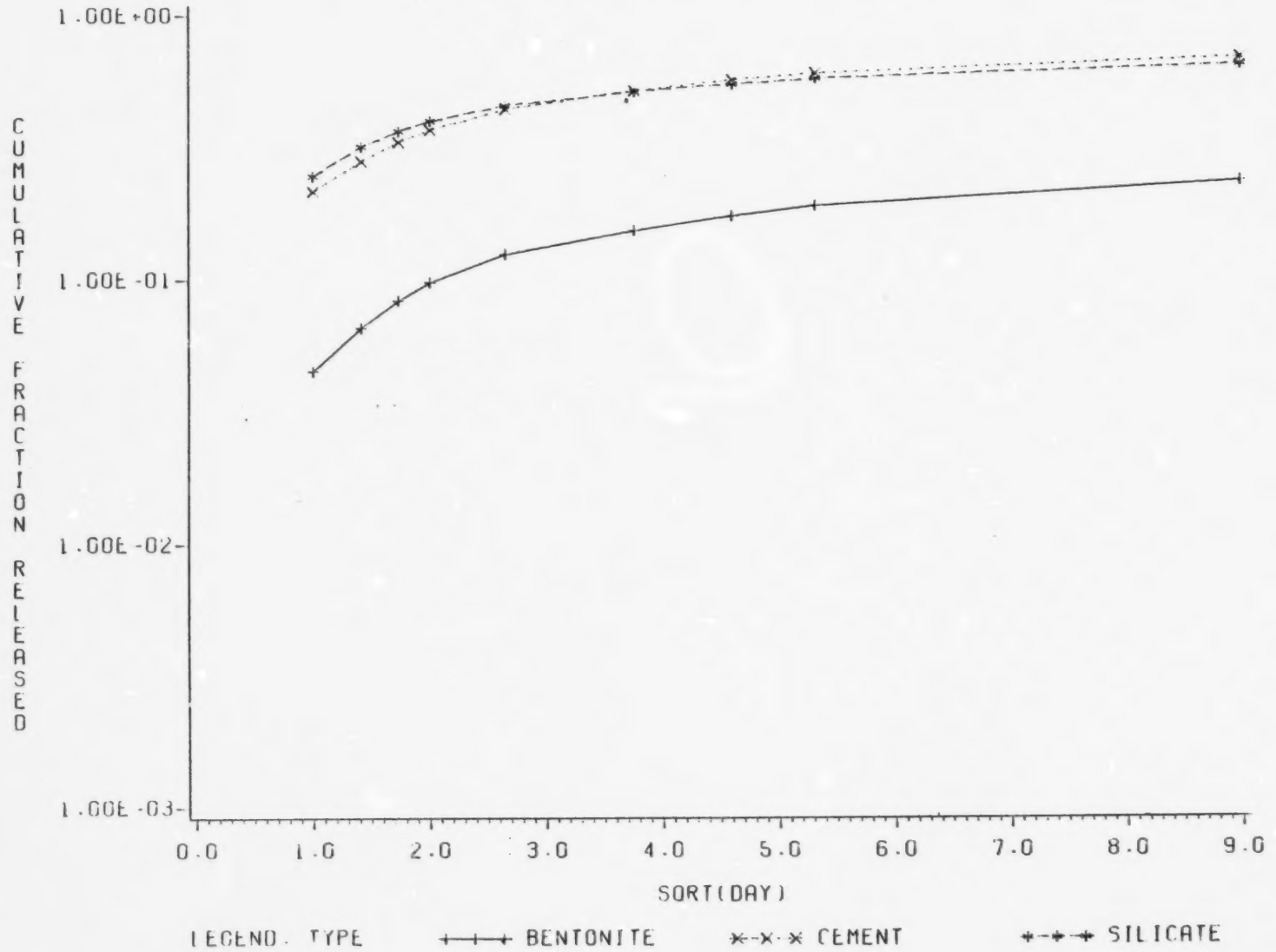


FIGURE 10

LEACHING RATES FROM CEMENTED DECONTAMINATION WASTES

WASTE=TURCO 4512



POOR

QUALITY

ORIGINAL